CBCS SCHEME

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18MR33

Third Semester B.E. Degree Examination, Feb./Mar. 2022
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Thermodynamic data hand book is permitted.***

Module-1

1 a. Distinguish between :
i) Intensive and extensive properties
ii) Point function and path function
iii) Open system and Closed system. **(06 Marks)**

b. What is Thermodynamic equilibrium? Explain mechanical, chemical and thermal equilibrium by means of examples. **(06 Marks)**

c. Two Celsius thermometer 'A' and 'B' agree at ice point and steam point, and are related by equation $t_A = L + Mt_B + N t_B^2$ where L_1 M and N are constants. When both thermometers are immersed in a fluid, 'A' registers 26°C while B registers 25°C. Determine the reading of 'A' when 'B' reads 37.4°C. **(08 Marks)**

OR

2 a. Starting from a common state point, draw following processes on PV-place, and derive expression for workdone in each case.
i) ISO baric process
ii) ISO thermal process
iii) Polytropic process. **(08 Marks)**

b. A fluid at 0.7 bar occupying $0.09m^3$ is compressed reversibly to a pressure of 3.5bar according to a law PV^n = constant. The fluid is then heated reversibly at constant volume unit the pressure is 4 bar, the specific volume is then $0.5m^3/kg$. A reversible expansion according to a law PV^2 = constant restores the fluid to its initial state. Sketch the cycle on a P-V diagram and calculate :
i) The mass of fluid present
ii) The value on index 'n' in the first process
iii) The network of the cycle. **(12 Marks)**

Module-2

3 a. Derive an expression for steady flow energy equation giving the assumptions. **(06 Marks)**

b. State the first law of thermodynamics for a process. Show that energy is a property of the system. **(06 Marks)**

c. Steam enters a turbine with a pressure of 4800 KPa, internal energy of 3000kJ/Kg, enthalpy of 3224 kJ/kg and with a flow of 6Kg/s. Steam leaves with an internal energy of 2000kJ/Kg, enthalpy of 2100kJ/Kg and pressure of 20KPa. There is radiative heat loss equal to 25kJ/Kg. Determine:
i) Power produced in KW
ii) The exit velocity if the exit area is $0.5m^2$.

(08 Marks)

OR

4 a. Give Kelvin Plank and Clausius statement of second law of thermodynamic. **(04 Marks)**

b. State and prove Carnot's theorem. **(06 Marks)**

c. A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine driver a reversible refrigeration, which operates between reservoirs at temperatures of 40°C and -20°C. The heat transfer to the heat engine is 2000kJ and the net work output of the combined engine refrigerator plant is 360kJ. Find the heat transfer to the refrigerant and net heat transfer to the reservoir at 40°C. Assume that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values. **(10 Marks)**

Module-3

5 a. Define entropy and prove that is a property of system. **(06 Marks)**

b. State and prove Clausius inequality. **(06 Marks)**

c. A 5Kg copper block at temperature of 200°C is dropped into an insulated tank containing 100Kg oil at a temperature of 30°C. Find the increase in entropy of universe due to this process when copper block and oil reach thermal equilibrium. Assume $(C_p)_{copper}$ = 0.4kJ/Kg K and $(C_p)_{oil}$ = 2.1kJ/Kg K. **(08 Marks)**

OR

6 a. Define the following :

i) Triple print
ii) Critical point
iii) Subcooled liquid
iv) Dryness fraction. **(04 Marks)**

b. Draw a neat sketch of throttling calorimeter and explain how dryness fraction of steam is determined. **(06 Marks)**

c. A pressure cooker contains 1.5Kg of saturated steam at 5 bars. Find the quantity of heat which must be rejected so as to reduce the quality to 60% dry. Determine the pressure and temperature of the steam in the new state. **(10 Marks)**

Module-4

7 a. Derive Maxwell's relations for a simple compressible system in the form $\left(\frac{\partial M}{\partial y}\right)_X = \left(\frac{\partial N}{\partial x}\right)_Y$ **(08 Marks)**

b. Show that in an isobaric process, heat transferred is equal to change in enthalpy. **(04 Marks)**

c. 1Kg of air with an initial volume of 0.25m^3 is heated at constant pressure of 0.4MPa until its volume is doubled. Calculate :

i) Initial and final temperature of air
ii) Heat transferred
iii) External workdone
iv) Changes in entropy **(08 Marks)**

OR

8 a. Derive an expression of change in entropy of an ideal gas. **(08 Marks)**

b. Distinguish between universal gas constant and particular gas constant. **(04 Marks)**

c. 2 Kgs of an Ideal gas is contained in a rigid cylindrical vessel at temperature of 32°C. If 21.1kJ of heat is added to the gas, calculate the following :

i) Final temperature
ii) Change in enthalpy
iii) Change in entropy. **(08 Marks)**

Module-5

9 a. State and explain :
   i) Dalton's law of partial pressures
   ii) Amagat's law of partial volumes **(06 Marks)**

b. Derive the expression for Gas constant and Molecular weight of a mixture of ideal gases. **(06 Marks)**

c. A gas mixture consists of 0.5kg of (CO) Carbon monoxide and 1Kg of Carbon dioxide (CO_2). Determine :
   i) Mass fraction of each component
   ii) Mole fraction of each component
   iii) The average molecular weight
   iv) The gas constant for the mixture. **(08 Marks)**

OR

10 a. Derive Vander Waal's constants in terms of critical properties. **(08 Marks)**

b. Write a note on :
   i) Law of corresponding states
   ii) Compressibility factor **(04 Marks)**

c. Calculate the pressure excreted by CO_2 in a container of $1.5m^3$ capacity when it contains 5Kg capacity at 27°C by using
   i) Ideal gas equation
   ii) Vander Waal's equation.

   Also calculate the compressibility factor by using the answer obtained from Vander Waal's equation. Take a = 364.3KPa, b = $0.0427m^3$Kg/mole **(08 Marks)**

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